

Digitalis in Open Heart Operations

SOL BERNSTEIN, M.D., JOHN E. MEIHAUS, M.D.,
OSCAR MAGIDSON, M.D., and JEROME HAROLD KAY, M.D., Los Angeles

SINCE THE TIME of Withering, cardiac glycosides have been the most important pharmaceutical agents in the management of congestive heart failure. The basis for present-day digitalis therapy is many years of clinical experience and research.^{5,11} The major indications for the use of digitalis fall into two categories, namely, congestive heart failure and supraventricular tachycardias.^{3,4,6} Prophylactic digitalization in the absence of heart failure has been considered by some observers to be useless, by some harmful.^{6,7}

While numerous studies have shown that digitalis may decrease the cardiac output in a normal heart, the results of studies on a diseased but not failing heart have been contradictory. Some investigators have reported demonstrating a fall in cardiac output, while others have observed no effect upon output at all.⁶ Whether prophylactic digitalization is useful in patients with heart disease but not in failure has not been conclusively proved; however, opinion now seems to favor the view that a digitalization can be carried out in such circumstances without fear of decreasing cardiac output or producing detrimental effects on blood pressure.

The use of open heart surgical techniques (with extracorporeal circulation) for the correction of many congenital and acquired cardiac defects raises the question of another possible indication for digitalis, namely, that of increasing the efficiency of a nonfailing hypertrophied heart to which surgical trauma has been added.^{1,2,9}

The purpose of this communication is to present our experience, impressions and techniques regarding digitalis therapy gained in the use of open heart operation, with extracorporeal circulation of blood through a stationary screen oxygenator,⁸ for the treatment of 300 patients with congenital and acquired heart disease.

At the completion of cardiopulmonary by-pass it was noted that in some cases the heart contractions were weak and the blood pressure could not be maintained. In such cases, intravenous administration of rapid-acting cardiac glycosides brought about improved myocardial efficiency, as evidenced by

• In addition to the usually accepted indications for digitalis therapy, we believe there is a group of patients, not having heart failure, who would benefit from digitalis in connection with open operations on the heart. This group includes all adults, all with the tetralogy of Fallot, and all with high pressure ventricular septal defects. Digitalis preparations can be given in the usual digitalizing doses several days before operation to insure the presence of some glycosides at the end of the operation when cardiopulmonary by-pass is discontinued. An additional maintenance dose can be given by the anesthetist at the time of completion of cardiopulmonary by-pass and another dose the evening of operation. If during the immediate postoperative period supraventricular arrhythmia occurs, particularly tachycardia, the ouabain test is extremely useful and safe in determining whether or not more digitalis is needed.

stronger myocardial contraction and an increase and better maintenance of blood pressure. This was particularly evident in the early cases when the heart had been arrested by potassium or anoxic cardioplegia for long periods during the open heart repair. It was noted more frequently with some types of defects than with others. Through close observation of the exposed heart immediately after by-pass, it was found that digitalis was valuable and, in our experience, was indicated for all adults undergoing open heart operations, all patients with tetralogy of Fallot, and all patients with high pressure ventricular septal defects. At times the trauma of right or left ventriculotomy during by-pass, added to hypertrophy of the myocardium, resulted in inefficient contractions unless digitalis was used. Feeling that administration of digitalis the instant circulatory by-pass was ended was beneficial, we came next to the question whether digitalization before operation and the addition of more of the drug at the time by-pass was ended might not be even more helpful. This method was used in the last 200 cases (adults and patients with tetralogy of Fallot and high pressure ventricular septal defects) with gratifying results. Immediate postoperative dilatation and failure did not occur, and the blood pressure as well as cardiac output were within normal range in the immediate postoperative period. One problem did arise, however, with regard to digitalization before and after operation. This was the un-

Aided by a grant from the United States Public Health Service, from the Department of Medicine and Surgery of the University of Southern California School of Medicine, the St. Vincent's Hospital, and the Los Angeles County General Hospital, Los Angeles 33.

Submitted November 15, 1960.

answered question of how much digitalis remained in the body after discontinuing pump circulation and therefore how much more digitalis was required during the first few days after operation to insure adequate digitalization. In most cases a daily maintenance dose of digitalis preparation was given intramuscularly shortly after the by-pass was ended, and this was repeated the evening of the operation. In some patients tachycardia or arrhythmia persisted and in these patients it was found useful to perform a ouabain indication test postoperatively. This helped to determine how much additional digitalis preparation was necessary. The acetyl strophanthidin test was not used because we lacked experience with it.

Other investigators have reported, with regard to operations of all kinds on patients previously taking digitalis, the need for additional digitalis after operation. This applies to general abdominal surgical procedures as well as to cardiac and thoracic operations^{5,11} such as mitral commissurotomy and hypothermic repair of atrial septal defects.

The use of cardiopulmonary by-pass poses a unique problem. Since there is a constant mixing of the patient's blood with large volumes of donor blood, it is impossible at present to accurately calculate how much glycoside remains in the tissues and how much is "washed out" during operation. Some glycosides, notably digitoxin, have a strong affinity for serum protein; however, how much remains in the tissues as well as in the serum after by-pass is unknown, and we know of no studies to determine this. The ouabain test, as carried out in the present series of cases, consists of the dilution of 1 ampule of ouabain (0.5 mg.) in 20 cc. of 5 per cent glucose and water. This is given slowly at the rate of 1 cc. per minute intravenously with constant electrocardiographic monitoring. The injection is stopped at the first sign of digitalis intoxication, as manifested by the appearance of ventricular ectopic beats, decrease in blood pressure, nausea or bizarre arrhythmia. In ten patients a persistent nodal tachycardia or atrial flutter during the first postoperative week necessitated complete redigitalization as suggested by the ouabain test. In one patient who had open heart repair of calcific aortic stenosis, atrial flutter developed 30 hours after operation. He was completely redigitalized, using digitoxin, and then 0.3 mg. of digitoxin was given daily for several days, but the arrhythmia persisted. The ouabain test on the seventh postoperative day revealed that 0.5 mg. of ouabain was necessary to convert the flutter from a 2:1 ventricular

response with a ventricular rate of 150 to a 4:1 response and a ventricular rate of 75. The patient was redigitalized for a second time and the flutter was finally converted to atrial fibrillation. With large daily maintenance doses of gitaligin (1.0 mg. three times a day) for an additional three days, the fibrillation reverted to sinus rhythm. Another patient was operated upon for a ruptured sinus of Valsalva aneurysm, with a large communication from the aorta into the right ventricle. At the time of operation a congenital ventricular septal defect and pulmonary stenosis were also repaired. During the immediate postoperative period the condition of the patient was satisfactory except for the development of nodal tachycardia with resultant drop in blood pressure, and the appearance of prominent "A" waves in the jugular pulse. The ouabain test revealed the necessity for complete redigitalization, which was accomplished with digitoxin. The rhythm was converted to sinus and the patient made an uneventful and complete recovery.

1200 North State Street, Box 486, Los Angeles 33 (Kay).

ADDENDUM

After this paper was written, the work of Cooper and coworkers² came to our attention. Their experimental data would confirm our clinical impression of the usefulness of digitalis in open heart operations.

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